Amendments to the claims are presented herein by presenting a complete set of pending claims, as amended, in clean form. Also, an Appendix entitled "Version With Markings to Show Changes Made," showing the current amendments to the claims is attached hereto.

Please amend the above-identified application as follows:

IN THE CLAIMS:

Please cancel claim 10 without prejudice.

Please replace the previous version of the claims with the following clean version, wherein claims 1-9 and 11-17 incorporate new amendments thereto, and claim 10 has been cancelled without prejudice.

1. (Once Amended) An actuator comprising:

a plurality of displacing devices for generating displacements;

a compound member, connected to the displacing devices, for compounding displacements of the displacing devices;

a base member for holding base ends of the displacing devices to which the compound member is not connected;

a pressing member for pressing the compound member to an object to be driven; and

a driver for resonantly driving the displacing devices so as to move the compound member along an elliptic or a circular trail.

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Sub C1

2. (Once Amended) An actuator in accordance with claim 1, wherein a natural frequency of the displacing devices in a first natural vibration mode, in which the displacing devices are resonantly vibrated in the same phase, substantially coincides with a natural frequency of the displacing devices in a second natural vibration mode, in which the displacing devices are resonantly vibrated in the opposite phase.

3. (Once Amended) An actuator in accordance with claim 2, wherein a mass of the compound member is designated by a symbol "M", a length of each displacing device is designated by a symbol "L", a height of each displacing device is designated by a symbol "H", and a mass of each displacing device is designated by a symbol "m", and the equation

$$M=(L^2/H^2-0.88)m/2.63$$

is satisfied.

4. (Once Amended) An actuator in accordance with claim 2,

wherein a mass of the compound member is designated by a symbol "M_c", a mass of each displacing device is designated by a symbol "m", a spring constant of each displacing device in the expansive deformation is designated by a symbol "k_1", a spring constant of each displacing device in the bending deformation is designated by a symbol "k_3", a moment of inertia of the base member is designated by a symbol "I_z", a rotation

Sub C1 cont.

radius of the base member is designated by a symbol "R", and an equivalent mass of the base member converted to a cantilever is designated by a symbol "M_h'", and the equations

$(k_1/(1-p))/(M_c+(1-p)m/3)=(k_1/(1-q)+k_3)/(M_c+(1-q)m/3+m/2)$

$p=(M_c+m/3)/(M_c+I_z/R^2+2m/3)$

$q=(M_c+5m/6)/(M_c+M_h'+7m/6)$

are satisfied.

5. (Once Amended) An actuator in accordance with claim 1, wherein at least one of the plurality of displacing devices includes an elastic member as a part thereof.

Contd B1

6. (Once Amended) An actuator comprising:

a first displacing device;

a second displacing device;

a compound member connected to top ends of the first displacing device and the second displacing device and for compounding displacements of the first displacing device and the second displacing device; and

a driver for resonantly driving the displacing devices so as to move the compound member along an elliptic or a circular trail,

wherein the driver drives the first displacing device and the second displacing device by driving signals respectively having a frequency that is between a first frequency and a second frequency,

wherein the first frequency is a higher one of a resonant frequency of the first displacing device and a resonant frequency of the second displacing device, and

wherein the second frequency is a lower one of an antiresonant frequency of the first displacing device and an antiresonant frequency of the second displacing device.

7. (Twice Amended) An actuator comprising:

a first displacing device;

a second displacing device;

Sub C1 cont.

a compound member connected to top ends of the first displacing device and the second displacing device and for compounding displacements of the first displacing device and the second displacing device; and

a driver for resonantly driving the displacing devices so as to move the compound member along an elliptic or a circular trail,

wherein the driver drives the first displacing device and the second displacing device by using a first displacing device driving signal and a second displacing device driving signal, respectively, each of the driving signals having a frequency included in an overlapped region of a first frequency band and a second frequency band,

Cont'd B1

wherein the first frequency band is defined as a region between a resonance frequency of the first displacing device and an antiresonance frequency of the first displacing device in which a phase difference between a phase of a voltage of the first displacing device driving signal and a phase of a current flowing in the first displacing device is substantially constant,

wherein the second frequency band is defined as a region between a resonance frequency of the second displacing device and an antiresonance frequency of the second displacing device in which a phase difference between a phase of a voltage of the second displacing device driving signal and a phase of a current flowing in the second displacing device is substantially constant,

wherein the frequency of the driving signals is a value at the center between a first frequency and a second frequency,

wherein the first frequency is a smaller one of the resonance frequencies of the first displacing device and the second displacing device, and

wherein the second frequency is a smaller one of the antiresonance frequencies of the first displacing device and the second displacing device.

8. (Twice Amended) An actuator in accordance with claim 6, wherein the phase of the driving signal for driving the first displacing device has a phase difference with respect to the driving signal for driving the second displacing device.

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SUB C1 cont.

9. (Once Amended) An actuator comprising:

a first displacing device;

a second displacing device;

a compound member connected to top ends of the first displacing device and the second displacing device and for compounding displacements of the first displacing device and the second displacing device;

a driver for resonantly driving the displacing devices so as to move the compound member along an elliptic or a circular trail, and

current sensors respectively for sensing currents flowing in the first displacing device and the second displacing device,

Contd B1

wherein the driver drives the first displacing device and the second displacing device by using a first displacing device driving signal and a second displacing device driving signal, respectively, each of the driving signals having a frequency included in an overlapped region of a first frequency band and a second frequency band,

wherein the first frequency band is defined as a region between a resonance frequency of the first displacing device and an antiresonance frequency of the first displacing device in which a phase difference between a phase of a voltage of the first displacing device driving signal and a phase of a current flowing in the first displacing device is substantially constant, and

wherein the second frequency band is defined as a region between a resonance frequency of the second displacing device and an antiresonance frequency of the second displacing device in which a phase difference between a phase of a voltage of the second displacing device driving signal and a phase of a current flowing in the second displacing device is substantially constant.

11. (Once Amended) An actuator in accordance with claim 12, wherein a phase difference is provided between the driving signals in a manner so that a current flowing in the first displacing device has a predetermined phase difference with respect to a current flowing in the second displacing device.

Sub C1 cont.

12. (Once Amended) An actuator comprising:

a first displacing device;

a second displacing device;

a compound member connected to top ends of the first displacing device and the second displacing device and for compounding displacements of the first displacing device and the second displacing device;

a driver for resonantly driving the displacing devices so as to move the compound member along an elliptic or a circular trail; and

current sensors respectively for sensing currents flowing in the first displacing device and the second displacing device,

Contd B1

wherein the driver drives the first displacing device and the second displacing device by driving signals respectively having a frequency included in a frequency band in the vicinity of resonance frequencies of the first displacing device and the second displacing device at which a displacement of the first displacing device is substantially the same as that of the second displacing device.

13. (Once Amended) A method for driving an actuator which comprises a first displacing device, a second displacing device, and a compound member connected to top ends of the first displacing device and the second displacing device for compounding displacements of the first displacing device and the second displacing device, said method comprising the step of:

driving each of the first displacing device and the second displacing device in a manner so as to move the compound member along an elliptic or a circular trail by using a first displacing device driving signal and a second displacing device driving signal, respectively, each of the driving signals having a frequency that is between a first frequency and a second frequency,

wherein the first frequency is a higher one of a resonant frequency of the first displacing device and a resonant frequency of the second displacing device, and

wherein the second frequency is a lower one of an antiresonant frequency of the first displacing device and an antiresonant frequency of the second displacing device.

Sub C1 cont.

14. (Twice Amended) A method for driving an actuator which comprises a first displacing device, a second displacing device, and a compound member connected to top ends of the first displacing device and the second displacing device for compounding displacements of the first displacing device and the second displacing device, said method comprising the step of:

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driving each of the first displacing device and the second displacing device in a manner so as to move the compound member along an elliptic or a circular trail by using a first displacing device driving signal and a second displacing device driving signal, respectively, each of the driving signals having a frequency included in an overlapped region of a first frequency band and a second frequency band,

wherein the first frequency band is defined as a region between a resonance frequency of the first displacing device and an antiresonance frequency of the first displacing device in which a phase difference between a phase of a voltage of the first displacing device driving signal and a phase of a current flowing in the first displacing device is substantially constant,

wherein the second frequency band is defined as a region between a resonance frequency of the second displacing device and an antiresonance frequency of the second displacing device in which a phase difference between a phase of a voltage of the second displacing device driving signal and a phase of a current flowing in the second displacing device is substantially constant,

wherein the frequency of the driving signals is a value at a center between a first frequency and a second frequency,

wherein the first frequency is a smaller one of the resonance frequencies of the first displacing device and the second displacing device, and

wherein the second frequency is a smaller one of the antiresonance frequencies of the first displacing device and the second displacing device.

15. (Once Amended) A method for driving the actuator in accordance with claim 13, wherein the phase of the first displacing device driving signal has a phase difference with respect to the second displacing device driving signal.

Sub C1 cncl'd.

16. (Once Amended) A method for driving an actuator which comprises a first displacing device, a second displacing device, and a compound member connected to top ends of the first displacing device and the second displacing device for compounding displacements of the first displacing device and the second displacing device, said method comprising the step of:

driving each of the first displacing device and the second displacing device in a manner so as to move the compound member along an elliptic or a circular trail by using a first displacing device driving signal and a second displacing device driving signal, respectively, each of the driving signals having a frequency included in a frequency band in the vicinity of resonance frequencies of the first displacing device and the second displacing device at which a displacement of the first displacing device is substantially the same as that of the second displacing device; and

Cont'd B1

sensing a current flowing through the first displacing device and a current flowing through the second displacing device.

17. (Once Amended) A method for driving the actuator in accordance with claim 16, further comprising the step of adjusting a phase difference between the first displacing device driving signal and the second displacing device driving signal so that the current flowing in the first displacing device has a predetermined phase difference with respect to the current flowing in the second displacing device.

Drawings

To date, no Notice of Draftsperson's Patent Drawing Review has been received. Applicants respectfully request receipt of this document when it becomes available. Please note that the original drawings filed in the patent application are "formal" drawings.

Claim Amendments

Claim 10 has been cancelled.

Claims 6, 13, and 16 have been amended to more particularly point out and distinctly claim the invention. Claims 7, 9, 12, and 14 have each been rewritten in independent form.

Claim 11 has been amended to depend from claim 12, and claim 17 has been amended to depend from claim 16. Claims 1-5, 8, 11, 15, and 17 have been amended to improve the grammar thereof, including a change to claim 15 to overcome the objection thereof. These amendments to claims 1-5, 8, 11, 15, and 17 have no relation to the patentability of the invention as claimed in this application.

Supplemental Information Disclosure Statement

A Supplemental Information Disclosure Statement is being submitted herewith in accordance with the duty of disclosure set forth in 37 C.F.R. § 1.56. While no representation is made, and no representation is intended, that more relevant material does not exist, including material amongst that which is submitted in the Supplemental Information Disclosure Statement submitted herewith, Applicants wish to direct the Examiner's attention to the following references:

> U.S. Patent No. 6,066,911 to Lindemann et al (hereinafter the "Lindemann patent"), and
>
> "Transducers for High Speed and Large Thrust Ultrasonic Linear Motor Using Two Sandwich-type Vibrators" by Minoru Kurosawa et al. IEEE, TRANSACTIONS ON ULTRASONICS, FERROELECTRICS,

AND FREQUENCY CONTROL, Vol. 45, No. 5, September 1998, pp. 1188-1195 (hereinafter the "Kurosawa publication").

The Lindemann patent is directed towards an ultrasonic driving element that includes one or more stacks of piezoelectric layers. A point on each stack is designated as a surface point for pressing against an object to be driven. Each of the stacks of piezoelectric layers includes electrodes disposed therein, and an AC voltage is applied to the electrodes to drive the stack of piezoelectric layers. The stack may be driven in such a way that an elliptical motion is induced in the point of the stack for pressing against the object to be driven. In one embodiment, shown in Fig 7, the stack of piezoelectric layers has a V-shaped structure, with electrodes 73 and 74 disposed therein, and a friction point 71 for contacting an object to be driven. The path P3 illustrates an elliptical path that the friction point 71 may be driven to follow.

The Lindemann patent cannot anticipate of render obvious the present claims for several reasons. For example, the Lindemann patent fails to disclose or suggest a compound member connected to two or more stacks of piezoelectric layers. The Lindemann patent also fails to disclose or suggest a pressing member for pressing a compound member to an object to be driven as recited in claim 1. Finally, the Lindemann patent fails to disclose or suggest sensing a current flowing through the displacing devices as recited in claim 16.

The Kurosawa publication is directed towards a transducer, as shown in Fig. 1 of the Kurosawa publication, that includes two arms orthogonal to one another, each arm including piezoelectic layers, electrodes, and a nut and bolt for holding each arm to a common hold block. The transducer also includes a head block connected to each arm of the transducer. The Kurosawa publication discloses that an AC voltage can be applied to the electrodes to drive the tip of the head block along an elliptical trail. The Kurosawa publication also discloses that the bolt can be used to pre-stress the piezoelectric elements by applying a compression force thereto and thereby compensating for a relatively low tensile strength of the piezoelectric elements.

The Kurosawa publication also cannot anticipate or render obvious the present claims for several reasons. For example, the Kurosawa publication fails to disclose or suggest a pressing member for pressing the tip of the head block to an object to be driven as recited in claim 1. The Kurosawa publication also fails to disclose or suggest the use of driving frequencies other than resonance frequency as recited in claims 6, 7, 9, and 12-14. Instead, the length of the end nuts is varied in order to allow the use of the resonance frequency for the symmetric and the antisymmetric vibration modes. Finally, the Kurosawa publication fails to disclose or suggest sensing a current flowing through the displacing devices as recited in claim 16.

Claim Objections

The objection to claim 15 because of an informality in line 3, wherein it is believed that applicants intended to recite "has" rather than "gas", is noted. Accordingly, by this Amendment, "gas" has been changed to "has". It is, therefore, respectfully requested that the objection to claim 15 be reconsidered and withdrawn.

The objection to claims 3, 4, 7, 9, 12, and 14 as being dependent upon a rejected base claim, but allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims, and, in the case of claims 3 and 4, also rewritten to overcome the § 112 rejection thereof, is noted.

By this Amendment, claims 7, 9, 12, and 14 have each been rewritten in independent form, including all of the limitations of the base claim and any intervening claims. Therefore, claims 7, 9, 12, and 14 are considered to be in condition for allowance.

Claim 1, from which claims 3 and 4 depend, is considered to be in condition for allowance. Therefore, rewriting claims 3 and 4 in independent form would involve unnecessary expense and effort.

Accordingly, it is respectfully requested that the objection to claims 3, 4, 7, 9, 12, and 14 be reconsidered and withdrawn.

35 U.S.C. § 112 Rejection

The rejection of claims 1-5 under the second paragraph of 35 U.S.C. § 112 as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention, is respectfully traversed based on the following.

According to the Office Action, the basis for this rejection is the phrase "a base member for folding base ends of the displacing device" from claim 1, which is alleged to have no antecedent basis in the disclosure. However, by this Amendment, claim 1 has been amended to change the phrase to "a base member for *holding* base ends of the displacing devices" (emphasis added), for which there is clear antecedent basis in the specification. Therefore, claim 1 is considered to be fully in compliance with § 112.

Claims 2-5 are rejected due to their dependence on claim 1. However, since claim 1 is considered to be fully in compliance with § 112, claims 2-5 are considered to be fully in compliance with § 112 as well.

Accordingly, it is respectfully requested that the rejection of claims 1-5 under the second paragraph of 35 U.S.C. § 112 be reconsidered and withdrawn.

35 U.S.C. § 102(b) Rejections - The Okada Publication

The rejection of claims 1, 2, 5, 10, 11, 13, and 16 under 35 U.S.C. § 102(b) as being anticipated by the Okada publication, is respectfully traversed based on the following.

Claims 1, 2, and 5

Claims 2 and 5 depend from claim 1. Therefore, the following discussion of claim 1 applies equally to claims 2 and 5.

Claim 1 is directed towards an actuator comprising a plurality of displacing devices, a compound member, a base member, a pressing member "for pressing the